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Abnormal Growth of Spirogyra Cells.

By Emily L. Gregory.

(Plate CXXV.)

Some *Spirogyra* filaments were obtained for class work from the greenhouse of the Biological Department of the University of Pennsylvania, about the last of January, 1891. These were soon noticed to present an appearance of branching quite unlike that occurring in the ordinary process of reproduction. The regular routine of class work prevented any continued study of the processes of development, which soon showed themselves to be caused by the attacks of some low organisms, probably the monads described by Zopf. The only definite results obtained from such desultory study as could be given them at odd times have reference to the peculiar manner of growth caused by the irritating organism.

In many cases the malformation caused by parasites preying on Algæ is of a similar nature to that occurring in higher plants. In other words, the abnormal growth seems to be governed by the necessities of the irritating organism and adapts itself in a greater or less degree to the needs of the latter. Familiar examples of this are the so-called *Vaucheria* galls, whose morphological significance is still a matter of doubt. Whether the gall arises from the metamorphosis of a fruit branch, as some claim, or whether an entirely abnormal growth from the side or end of the *Vaucheria* cell, it usually attains a size and shape to accommodate the little rotifer and its eggs. So also in the case of the galls of certain species of *Oscillaria*, caused by the entrance of the zoospores of

Chytridiæ. The growth here does not much exceed that required for the development of the new organisms, and the shape assumed is one entirely suited to the needs of the parasite.

It was the difference in this respect which first excited curiosity in the case of the *Spirogyra* cells in question. The organisms causing the hypertrophy were not easily noticed, while the manner of growth suggested the normal development of root-like organs.

The first appearance of disease was that of separation between the cells of a filament. Then the chlorophyll bands began to lose their hold on the wall, shrinking away from it, at the same time losing their closeness of coil until they become nearly parallel with the long axis of the cell. Although no measurements were taken, this probably came from the growth of the cell without the chlorophyll contents keeping pace with it. The whole process lasted several weeks, and during all this time no traces of foreign organisms entering the cells of the *Spirogyra* were found. This is, however, easily accounted for by the irregularity of the observations and the lack of any high powers of magnification. The later development was such as to suggest the probable presence of certain monad forms which are known to prey upon different species of *Spirogyra*, causing more or less disorganization and disease.

If this were true, there were two very marked peculiarities in their development and results, differing from any account I have been able to find in relation to the development history of these little organisms. These are the singular distortion of the *Spirogyra* cells, before referred to, and the peculiar conduct of the monads after escaping from the cells.

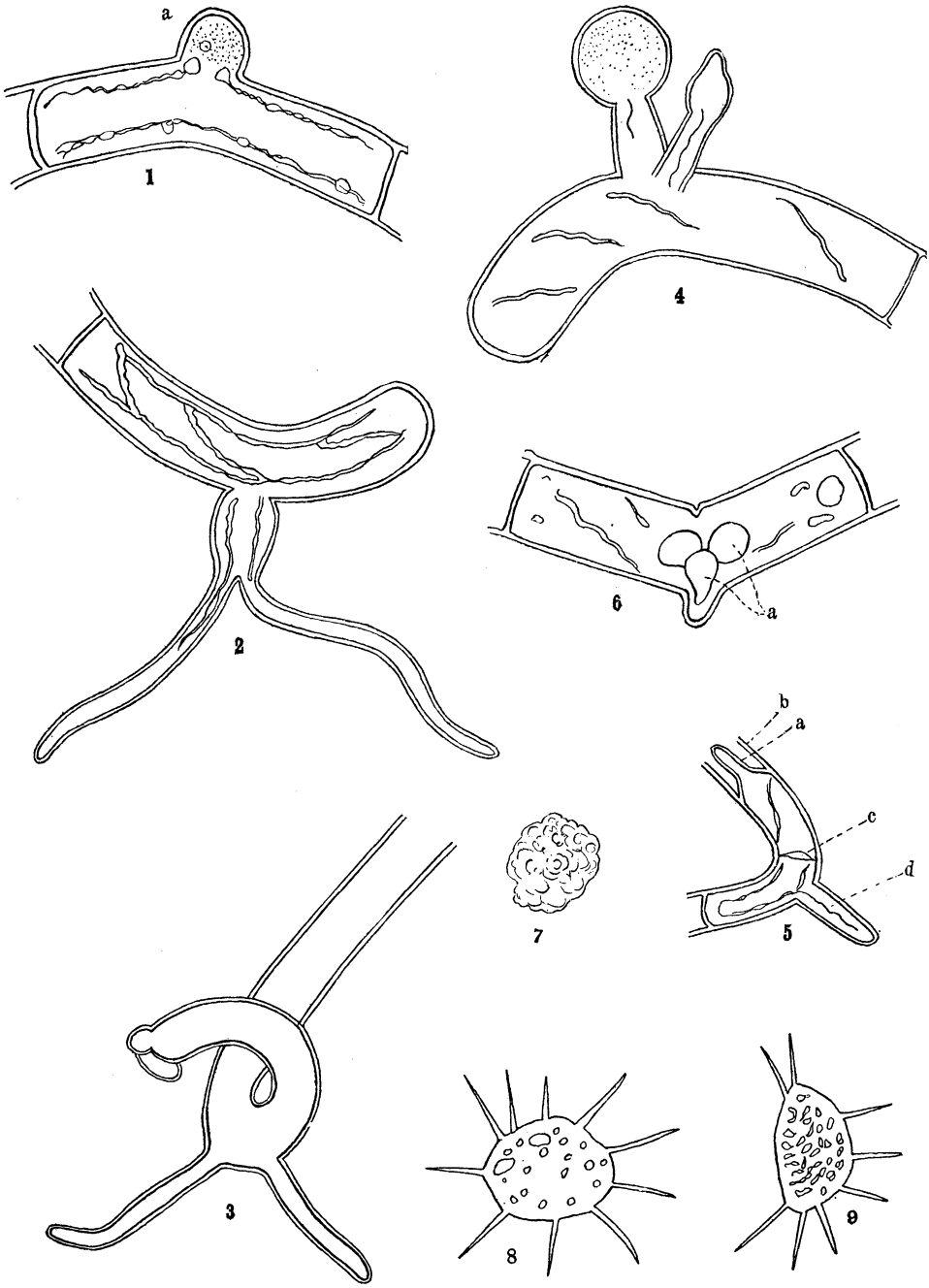
The first appearance of distortion was a lengthening of the wall on one side of the cell so as to produce almost a spiral coil. This seldom occurred in a long filament, but generally in one of one, two or three cells. From this bent or curved side of the cell was sent out a tube or branch, nearly at right angles with the long axis. This branch grew out more or less winding, tapering conically and often ended in a slight extension of a spherical shape. Very often this tube branched dichotomously, the branches then curling and twisting so they resembled small root-like appendages, so common to many Algæ forms. Several short filaments were found, consisting of only three or four cells, coiled several times,

and from each coil a tube projecting, afterward branching and the branches coiling and twisting toward the ends. The chlorophyll bands extended into these tubes, but with a feeble, unhealthy look and a loose coil which intimated rapid disintegration. Another perhaps equally common method of branching was from each end of the cell, or from the free ends of two cells still holding fast together. Here the appearance was still more root-like. The extending tube was never more than half the diameter of the cell and very often, forking several times it formed a little snarl of branches. This growing from the end of the cell sometimes happened before the cells of the filament separated, so that from the end of one cell projected a tube into the next, running perhaps half its length.

Cells in this condition in other ways never appeared perfectly healthy. Frequently the spirals were intact and the nucleus still in position, but generally the chlorophyll coils had straightened out, broken in places and appeared contracting into spherical bodies. This breaking up of the chlorophyll bands, according to the general method of development of the monads, we would suppose corresponds with the so-called amœboid stage of the parasite when it gorges itself with the chlorophyll of the cell. Singularly enough nothing whatever could be detected of the monad itself during the formation of unnumbered green spherical bodies, filling the cells more or less closely. The only apparent cause of the formation of these bodies was the collection of the chlorophyll masses about the pyrenoids and the gradual separation of these from each other. This is the more strange as the spores of the ordinary monad forms which attack the Algæ are not so small as to render them difficult of detection with the lens used, which was a number seven, of Leitz. Whatever the explanation may be, these bodies were formed inside the cells in immense numbers. In nearly all cases they retained their chlorophyll till after escaping from the cell, generally also in a bright, healthy condition; seldomer was it found to have turned a dull brownish color like the remains of chlorophyll described by Zopf as having been ejected by the monad.

These bodies generally escaped from the cell at night and hat through some break in the cell wall having no relation

whatever to the peculiar branches described before. In only one case did I notice any connection between these tubes and the occupation and departure of the monads. That is to say, the extraneous branches often contained a few smaller spherical bodies, but they seemed to originate and remain mostly in the original cells of the filament. Only in one case was their escape seen and this happened at about 11 A. M. A cell from which just the beginning of a tube projected, contained about four or five of these bodies, together with some slight remains of chlorophyll bands. Two of these worked their way slowly up to the projecting tube and passed into it and then out of the cell. The opening in the wall was apparently caused by the action of some secretion from the green monad as it disintegrated almost momentarily while I was watching it. The debris remained some time after both had escaped. The monads assumed the pear shape common to all such bodies when escaping through an orifice. Shortly after they were free they assumed a spherical form and were soon lost among the countless numbers of similar bodies. This was the only instance in which the escape was noted, because, as stated before, the exodus appeared to take place in the night. Every morning hordes of these green monads were found floating about among the broken cells. For several days after their exit from the cells they remained in about the same condition as at first. Then a change appeared; on examining the material in the morning certain ones had become very much enlarged, measuring at least twice as much in diameter as the others. These larger ones then went through a series of amœboid motions lasting several hours, but terminating in no special change which was lasting. As this seemed a regular habit of the enlarged ones several were watched closely through all the changing forms, and sketches made. The gyrations of one were followed through a period of about three hours and about forty sketches made. Others were noticed and a striking uniformity of change in shape appeared. To show this more clearly I requested one of my students to watch and sketch the evolutions of one, and the sketches were almost identical with my own. This peculiar series of motions never resulted in actual division, though appearing often as though this was the end in view. The whole returned



ABNORMAL GROWTH OF SPIROGYRA CELLS. Emily L. Gregory.

again to a spherical form and remained passive as before. Other cases were noticed where actual division took place, but this was never connected with the amœboid movement.

As the days passed, other changes occurred; a considerable number, after discharging the green parts of their contents, threw out cilia and remained as long as watched in this amœba condition. Some of these were watched closely during change of form and color, particularly one, which corresponds very closely to one figured by Zopf, as one stage of the monad *Pseudospora parasitica*, Cienk., which is well known for its fondness for *Spirogyra* cells. There were at least three distinct species of amœba found among the remains of these bodies, but their origin in all cases could not be determined.

The singularity connected with these organisms is the lack of proof that they were the developed form of certain monad spores which had bored their way into the cell, together with the fact that if they did have such an origin, they did not develop into the amœba stage inside the cell, but simply gorged themselves with food and then issued forth in swarms to pass through other stages outside. This, with the peculiar hypertrophy exhibited, which in only one case seemed to be of any use to the parasite, are the two features considered worthy of mention.

DESCRIPTION OF PLATE CXXV.

1.—*Spirogyra* cell showing beginning of tube formation at *a*. Contents of growing portion colorless but granulated.

2, 3 and 4.—Cells showing different stages of this development. The inner lines show remains of chlorophyll bands.

5.—A cell showing the second method, viz., the growth of tube into the adjacent cell. This seen at *a*. *c*. Cell nucleus. *d*. Another tube growing outward.

6.—Cell with only a slight projection, but from which the green bodies *a* are about to escape.

7.—Green body after having escaped.

8 and 9 —Amœba forms originating from such bodies as 7.

On the Names of two Species of Rhus.

Rhus cotinoides, Nutt.—Regarding the synonymy of this plant, perhaps a few words may be said in addition to the revision already published by Prof. Sargent in Garden and Forest, iv. 340. As there shown, the earliest name for this plant is that of Nuttall, *Cotinus Americanus* (1842–'50), and ac-